

Examination Of A Deep Subsurface Mars Polar Cap Mission To Address Climate History F. D. Carsey, K. Nock, G. Bearman, D. Kossakovski, and B. Wilcox, all at California Institute of Technology Jet Propulsion Laboratory, Pasadena CA 91109 (fcarsey@jpl.nasa.gov)

Introduction: We have examined the technological readiness of a mission to the Mars north polar area for the science objective of developing a climate history. We argue that the polar regions are scientifically extremely important mission sites from the perspectives of both climate history and astrobiology and that a polar deep subsurface mission would constitute a serious challenge and significant accomplishment. Thus a key question is: What is the technical readiness status of such a mission?

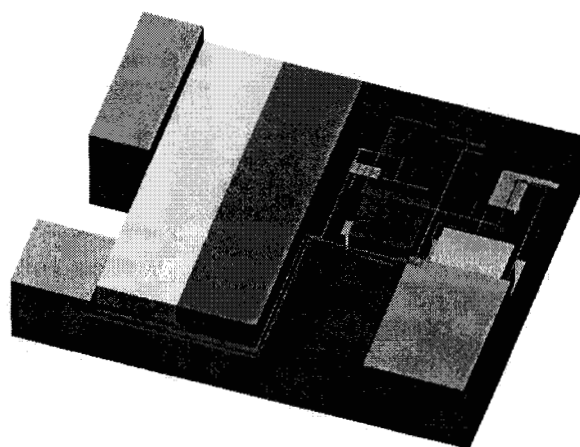


Fig. 1 The layout of a Mars surface analysis laboratory. Particles from the subsurface explorer would be moved in a capillary filled with high-pressure gas through a suite of instruments.

Mission Overview: We have taken the 2009 flight opportunity as a working launch period. To enhance geographic access and reduce costs, the mission profile is a Delta 2 or 3 launch with a 5 kW SEP cruise stage, involving about 2.5 years of flight, arriving at the Mars North Pole in November, 2011, resulting in > 100 days with the sun > 5° above the horizon for a site in the 85°-87°N latitude. The latitude selection is driven by our ability to drill the Polar Layered Deposits (PLD) and the time for which there is adequate insolation. Telecommunications from the site are planned to be direct to Earth, but orbital relay is seen as a good contingency. We note that landing-location accuracy is required, and that hazard avoidance may be called for according to recently published images.

Science: The overall topic of climate history was chosen. An alternate and very interesting mission could be focussed on life detection in the contact of the PLD and its basement, but uncertainties in the nature and scope of science instrumentation were seen to be significant. A strawman instrument set includes a mass spectrometer, microscopes at 1 and 10 micron

resolutions, ground-penetrating radar for subsurface survey and for tracking the subsurface explorer, Raman, Moessbauer and electron paramagnetic spectrometer for mineralogic information, and a luminescence dater.

Chronometry remains a crucial scientific technology. Our approach, which is not firmly established, is to consider luminescence dating as a technique to establish a 150,000-year baseline against which other schemes, e.g. $^3\text{He}/\text{He}$ abundances, stable and/or radioactive isotopes, etc., can be compared in order to construct a longer-term calendar for the deeper ice.

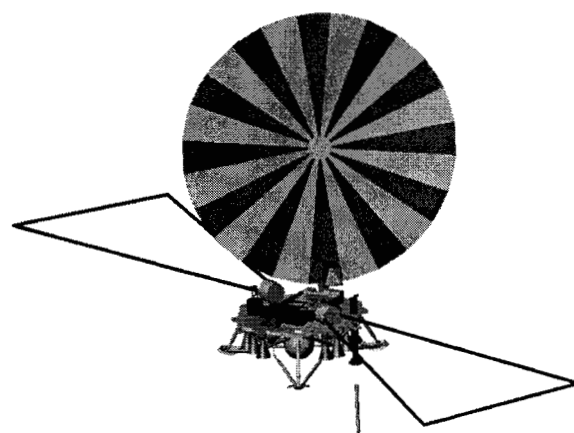


fig. 2. The MCHM lander with its large round solar collector, bow-tie sounding radar antenna, and subsurface explorer, deployed, at lower center.

Subsurface Explorer: Another key technology is the subsurface explorer; in this study the percussive drill has been used to gain access to the ice at depth. This device will be discussed elsewhere at this conference. The percussive drill acquires samples at depth by capturing material ground up by the drill and moving small particles (< 100 microns) to the surface through a capillary. In the 100 days of good sunlight at the North Pole, the subsurface explorer can drill through somewhat more than 1 km.

Summary: We conclude from our analysis that the deep subsurface exploration of a site such as the Mars PLD is within reach, a remarkable and exciting idea. Scientific analysis of the pulverized material from the drill can be addressed with quite good expectations. Developments are called for in the areas of precision landing site location and hazard avoidance, Chronometry of the PLD material, subsurface access methods, sample handling for scientific analysis, and scientific instrumentation.